PATENT ABSTRACTS OF JAPAN

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(71)Applicant : KODO EIZO GIJUTSU KENKYUSHO:KK

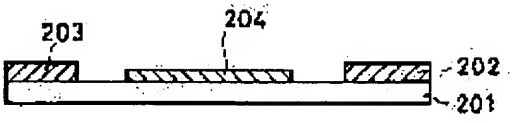
(72)Inventor : YUDASAKA KAZUO

(54) LIQUID CRYSTAL DISPLAY DEVICE AND ITS PRODUCTION

(57)Abstract:

PURPOSE: To obtain large mobility in TFT and to drive a device at high response by forming the TFT as the peripheral circuit to drive an active matrix on a single crystal silicon film.

CONSTITUTION: Single crystal silicon films 202, 203 providing the peripheral circuit to drive an active matrix are formed on an insulating substrate 201. In the area except for the single crystal silicon films 202, 203, polycrystalline silicon film or noncrystalline silicon film 204 is formed to form picture element transistors which drive picture element electrodes. The single crystal silicon film 202, 203 have thickness larger than the thickness of the polycrystalline silicon film or noncrystalline silicon film 204. Namely, by forming the silicon film thick, mobility in the electric characteristics of TFT to be formed can be improved, and thereby, operation speed of the peripheral circuit can be increased.



LEGAL STATUS

[Date of request for examination] 16.06.1994

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[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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PRIOR ART

[Description of the Prior Art] Conventionally, TFT used in the active-matrix substrate used for a liquid crystal display was formed on the polycrystal silicone film or the amorphous silicone film. With the active-matrix substrate which generally forms a circumference circuit in a monolithic, TFT (Poly-Si TFT) formed on a polycrystal silicone film is used, and TFT (a-Si TFT) formed on an amorphous silicone film is used by the active matrix formed using a large-sized substrate. a-Si Although a cheap and large-sized substrate can be used since the temperature of TFT of a manufacture process is low, mobility of this component cannot drive a circumference circuit small. On the other hand, it is Poly-Si. Although a substrate expensive [a quartz etc.] and small must be used since the temperature of TFT of a manufacture process is comparatively high, the mobility of this component has the capacity to drive a circumference circuit greatly. With the liquid crystal display by which current mass production is carried out, it is a-Si at a panel 10 inches or more, for example. TFT is used and it is Poly-Si with a liquid crystal display (1 inch thru/or about 3 inches). TFT is mainly used. It is because importance is in cost and the compactability of not only cost but the whole panel is important for the latter in the former.

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MEANS

[Means for Solving the Problem] Electrical characteristics are determined by the crystallinity of the silicon layer from which TFT serves as the channel layer. Since crystallinity becomes good at the order of an amorphous substance, polycrystal, and a single crystal, the property of TFT which makes them a channel layer, for example, mobility, will be good for the order. However, the active matrix from which all TFT(s) are constituted by the single crystal silicone film does not have best performance. Although the direction constituted from TFT with large mobility can form the circuit of high performance more since a circumference circuit is a digital circuit fundamentally, the mobility with usually big TFT for a pixel drive is not needed. The leakage current between source drains is more important than mobility rather. The optical leakage current when taking into consideration the temperature dependence of leakage current and a back light is also important. As a result of considering correlation with the property of these leakage current, and a display property, it turned out a result with it better [to constitute a channel layer using thin TFT using an amorphous substance or polycrystalline silicon] is obtained rather than having constituted TFT for a pixel drive using comparatively thick single crystal silicon.
[0007] Then, the liquid crystal display of this invention is formed on an insulating substrate and this insulating substrate, is formed in fields other than the single crystal silicone film with which the circumference circuit for driving an active matrix is formed, and the single crystal silicone film on said insulating substrate, and is characterized by having the polycrystal silicone film or amorphous silicone film with which the pixel transistor which drives a pixel electrode is formed.
[0008] The process which carries out patterning of the manufacture approach of the liquid crystal display of this invention to the configuration which constitutes the transistor of the circumference circuit which drives an active matrix for the single crystal silicone film formed on the insulating substrate etc., The process which deposits a polycrystal silicone film or an amorphous silicone film on said insulating substrate, The process which exposes said single crystal silicone film by which patterning was carried out at the same time it carries out patterning of said polycrystal silicone film or amorphous silicone film to the configuration which constitutes the pixel transistor of an active matrix, It is characterized by including the process which forms gate oxide on said polycrystal silicone film or an amorphous silicone film, and said single crystal silicone film.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since TFT of a circumference circuit which drives an active matrix is formed on a single crystal silicone film according to this invention as explained above, mobility can drive a liquid crystal display greatly at high speed.
[0023] Furthermore, since the channel layer of the pixel drive TFT which drives a pixel electrode can be made thin according to this invention, leakage current can be lessened and a display property improves.
[0024] Therefore, a highly minute, compact, and cheap liquid crystal display can be offered.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the liquid crystal display with which TFT (Thin Film Transistor) was formed on the so-called SOI (Silicon on Insulator) substrate or the SOS (Silicon on Sapphire) substrate, and its manufacture approach.
[0002]
[Description of the Prior Art] Conventionally, TFT used in the active-matrix substrate used for a liquid crystal display was formed on the polycrystal silicone film or the amorphous silicone film. With the active-matrix substrate which generally forms a circumference circuit in a monolithic, TFT (Poly-Si TFT) formed on a polycrystal silicone film is used, and TFT (a-Si TFT) formed on an amorphous silicone film is used by the active matrix formed using a large-sized substrate. a-Si Although a cheap and large-sized substrate can be used since the temperature of TFT of a manufacture process is low, mobility of this component cannot drive a circumference circuit small. On the other hand, it is Poly-Si. Although a substrate expensive [a quartz etc.] and small must be used since the temperature of TFT of a manufacture process is comparatively high, the mobility of this component has the capacity to drive a circumference circuit greatly. With the liquid crystal display by which current mass production is carried out, it is a-Si at a panel 10 inches or more, for example. TFT is used and it is Poly-Si with a liquid crystal display (1 inch thru/or about 3 inches). TFT is mainly used. It is because importance is in cost and the compactability of not only cost but the whole panel is important for the latter in the former.
[0003]
[Problem(s) to be Solved by the Invention] However, high performance-ization comes to be required of a circumference circuit with highly-minute-izing of a liquid crystal display in recent years, and it is Poly-Si. It is becoming difficult to attain the engine performance demanded also by TFT. It is because a speed of operation required of a circumference circuit in proportion to it will become quick if the number of pixels increases. When the number of pixels becomes 1 million or more, as for a speed of operation, 100MHz or more several 10MHz or more is ideally needed. Although it turns out that the property of TFT by the polycrystal silicone film also improves greatly with techniques, such as solid phase growth, laser annealing, and hydrogenation, high-speed operation 100MHz or more has also come to mass-produce many problems it is very difficult and concerning homogeneity, repeatability, dependability, etc. further.
[0004] In a liquid crystal display, the main advantages which can build in a circumference circuit are the compactability of cost reduction and the whole liquid crystal display. Therefore, it requires reduction-ization of cost simply not only a built part of a circumference circuit but that various defects of a panel are detectable in the state of a TFT substrate using a circumference circuit. It is because the substrate can be removed before a panel assembly or a defect can be corrected with a laser technique etc., if a defect is detectable in the state of a TFT substrate. If a liquid crystal display is made highly minute, so much, the yield will fall and cost will go up.
[0005] Then, an above-mentioned trouble is canceled, highly minute-ization is realized, and the purpose

of this invention is to offer the liquid crystal display which can operate TFT at high speed, and its manufacture approach.

[0006]

[Means for Solving the Problem] Electrical characteristics are determined by the crystallinity of the silicon layer from which TFT serves as the channel layer. Since crystallinity becomes good at the order of an amorphous substance, polycrystal, and a single crystal, the property of TFT which makes them a channel layer, for example, mobility, will be good for the order. However, the active matrix from which all TFT(s) are constituted by the single crystal silicone film does not have best performance. Although the direction constituted from TFT with large mobility can form the circuit of high performance more since a circumference circuit is a digital circuit fundamentally, the mobility with usually big TFT for a pixel drive is not needed. The leakage current between source drains is more important than mobility rather. The optical leakage current when taking into consideration the temperature dependence of leakage current and a back light is also important. As a result of considering correlation with the property of these leakage current, and a display property, it turned out a result with it better [to constitute a channel layer using thin TFT using an amorphous substance or polycrystalline silicon] is obtained rather than having constituted TFT for a pixel drive using comparatively thick single crystal silicon.

[0007] Then, the liquid crystal display of this invention is formed on an insulating substrate and this insulating substrate, is formed in fields other than the single crystal silicone film with which the circumference circuit for driving an active matrix is formed, and the single crystal silicone film on said insulating substrate, and is characterized by having the polycrystal silicone film or amorphous silicone film with which the pixel transistor which drives a pixel electrode is formed.

[0008] The process which carries out patterning of the manufacture approach of the liquid crystal display of this invention to the configuration which constitutes the transistor of the circumference circuit which drives an active matrix for the single crystal silicone film formed on the insulating substrate etc., The process which deposits a polycrystal silicone film or an amorphous silicone film on said insulating substrate, The process which exposes said single crystal silicone film by which patterning was carried out at the same time it carries out patterning of said polycrystal silicone film or amorphous silicone film to the configuration which constitutes the pixel transistor of an active matrix, It is characterized by including the process which forms gate oxide on said polycrystal silicone film or an amorphous silicone film, and said single crystal silicone film.

[0009]

[Function] Since TFT of a circumference circuit which drives an active matrix is formed on a single crystal silicone film according to this invention, mobility can drive a liquid crystal display greatly at high speed.

[0010] Furthermore, since the channel layer of the pixel drive TFT which drives a pixel electrode can be made thin according to this invention, leakage current can be lessened and a display property improves.

[0011]

[Example] Hereafter, the example of this invention is explained to a detail, referring to a drawing.

[0012] Drawing 1 is the typical sectional view of the SOS substrate used for the liquid crystal display concerning this invention.

[0013] The single crystal silicone film 102 is formed on the transparence insulating substrate 101. Such a substrate is marketed as an SOS substrate and can come to hand easily. Moreover, recently, it turns out that it can form by the substrate lamination method.

[0014] Drawing 2 is the typical sectional view showing the basic configuration of the liquid crystal display formed in the substrate shown in drawing 1 .

[0015] As shown in drawing 2 , since an active matrix is driven, on the transparence insulating substrate 201, the single crystal silicone films 202 and 203 with which a circumference circuit is prepared are formed. The polycrystal silicone film or the amorphous silicone film 204 with which the pixel transistor which is a viewing area for driving a pixel electrode is prepared in fields other than the single crystal silicone film 202 and 203 is formed.

[0016] Usually, in order to secure the crystallinity of the single crystal silicone film 202,203 formed on a transparence insulating substrate, it is necessary to make thickness of a single crystal silicone film to some extent thick, and this thickness is usually thousands of A. The reason is that defect density is high among single crystal silicone films in the place near a transparence insulating substrate. Therefore, thickness of the single crystal silicone films 202 and 203 for forming a circumference circuit is made into 5000A or more, and thickness of the polycrystal silicone film which forms TFT for a pixel drive by the viewing area, or the amorphous silicone film 204 is made into 1000A or less. By thickening thickness of the single crystal silicone films 202 and 203, in the electrical characteristics of TFT formed there, in N channel TFT, mobility becomes more than 200cm2 / v-s, and mobility can attain more than 100cm2 / v-s in P channel TFT. Therefore, a speed of a circumference circuit of operation can also attain dozens of MHz easily. Although very low leakage current is required on the other hand in order to hold the charge written in a pixel electrode to TFT for a pixel drive, TFT is formed on a polycrystal silicone film or the amorphous silicone film 204, and can be set to TFT of very low leakage current by making thickness of the channel layer of TFT into 500A or less.

[0017] Drawing 3 is process drawing showing the manufacture approach of the liquid crystal display concerning this invention. The single crystal silicone film 302 is formed on the transparence insulating substrate 301 (drawing 3 (a)). Next, patterning of the field which should serve as each source of TFT for the single crystal silicone film 302 to constitute a circumference circuit, a drain, and a channel is carried out (drawing 3 (b)). 302 shows an example of TFT by which patterning was carried out. in order [next,] to form TFT for a pixel drive -- a polycrystal silicone film or the amorphous silicone film 303 -- LPCVD -- it deposits so that thickness may become 1000A by law (drawing 3 (c)). Next, the field which should carry out patterning of this silicone film 303, and should serve as the source of TFT for a pixel drive, a drain, and a channel is formed (drawing 3 (d)). A silicone film 303 shows an example of TFT for a pixel drive. In drawing 3 (c), when carrying out etching removal of the polycrystal silicone film or the amorphous silicone film 303 on the single crystal silicone film 302, since thickness of 302 is sufficiently thick, it can carry out etching removal of 303 certainly.

[0018] Drawing 4 is the typical sectional view of the TFT component manufactured from the liquid crystal display shown in drawing 3 .

[0019] The manufacture approach of the TFT component shown in drawing 4 is explained.

[0020] TFT which constitutes a circumference circuit in the single crystal silicone film 302 is formed following the process of drawing 3 (d), and TFT for a pixel drive is formed in a polycrystal silicone film or the amorphous silicone film 303. Gate dielectric film 304 and 305 is formed in coincidence so that it may become 1000 thru/or the thickness of 1200A by thermal oxidation. While an amorphous silicone film turns into a polycrystal silicone film by this thermal oxidation, the thickness which had 1000A serves as thickness of about 400A.

[0021] Next, the gate electrodes 306 and 307 are formed in coincidence with polycrystalline silicon. Although not illustrated, the gate line for forming an active matrix may also be formed in coincidence with the same ingredient as the gate electrode 306,307. Next, an impurity is introduced into a source drain field by the ion implantation method, and an interlayer insulation film 308 is formed with a CVD method. Next, in 1000 degrees C, annealing is carried out to serve also as the eburnation of an interlayer insulation film 308, and activation of the driven-in ion. Next, after carrying out opening of the contact hole, aluminum film is deposited and the required wiring 309 and 310 is formed. 309 constitutes wiring of a circumference circuit and 310 becomes data wiring of an active matrix. Next, the ITO (Indium Tin Oxide) film used as a pixel electrode is formed, and an active matrix is completed.

[0022]

[Effect of the Invention] Since TFT of a circumference circuit which drives an active matrix is formed on a single crystal silicone film according to this invention as explained above, mobility can drive a liquid crystal display greatly at high speed.

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TECHNICAL PROBLEM

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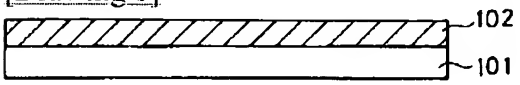
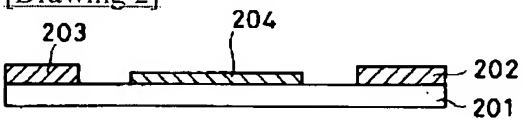
DRAWINGS

[Drawing 1]



[Drawing 2]



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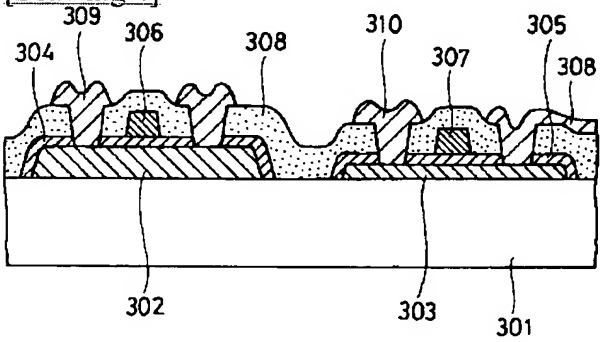
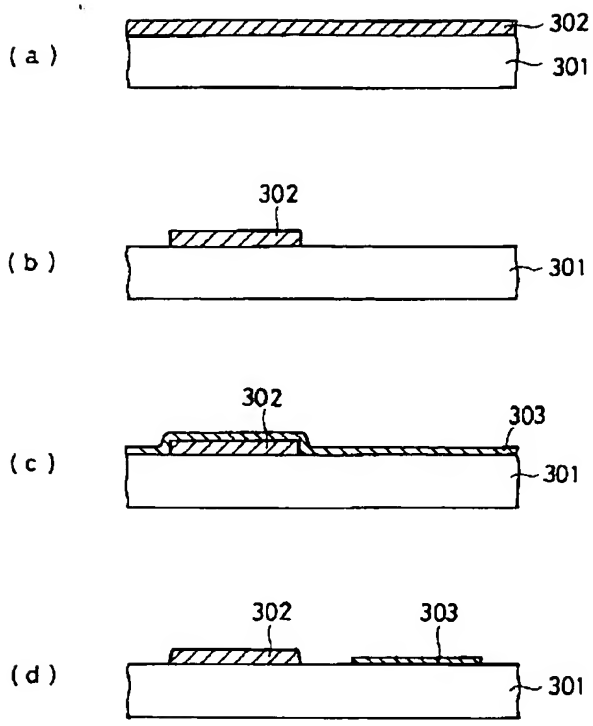


[Drawing 3]



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the typical sectional view of the substrate used for the liquid crystal display concerning this invention.
[Drawing 2] It is the typical sectional view of the liquid crystal display concerning this invention.
[Drawing 3] It is the typical sectional view showing the production process of the liquid crystal display concerning this invention.
[Drawing 4] It is the typical sectional view of the TFT component which applied this invention.
[Description of Notations]
101 Transparence Insulating Substrate
102 Single Crystal Silicone Film
201 Transparence Insulating Substrate
202,203 Single crystal silicone film
204 Polycrystal Silicone Film or Amorphous Silicone Film
301 Transparence Insulating Substrate
302 Single Crystal Silicone Film
303 Polycrystal Silicone Film or Amorphous Silicone Film
304,305 Gate dielectric film
306,307 Gate electrode
308 Interlayer Insulation Film
309 Wiring
310 Data Wiring

[Translation done.]